SPECIFICATION
FOR
APPROVAL

( ) **Preliminary Specification**

(●) **Final Specification**

Title	32.0” WUXGA TFT LCD

BUYER	LGE
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LC320EUA
SUFFIX	PFF1 (RoHS Verified)

APPROVED BY	SIGNATURE / DATE
/	
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/	

Please return 1 copy for your confirmation with your signature and comments.

APPROVED BY	SIGNATURE / DATE
H.S. Song / Team Leader	2012.12.26
REVIEWED BY	
S.S. Kim / Project Leader	2012.12.26
PREPARED BY	
Y.O. Kim / Engineer	

TV Product Development Dept.
LG Display Co., Ltd.

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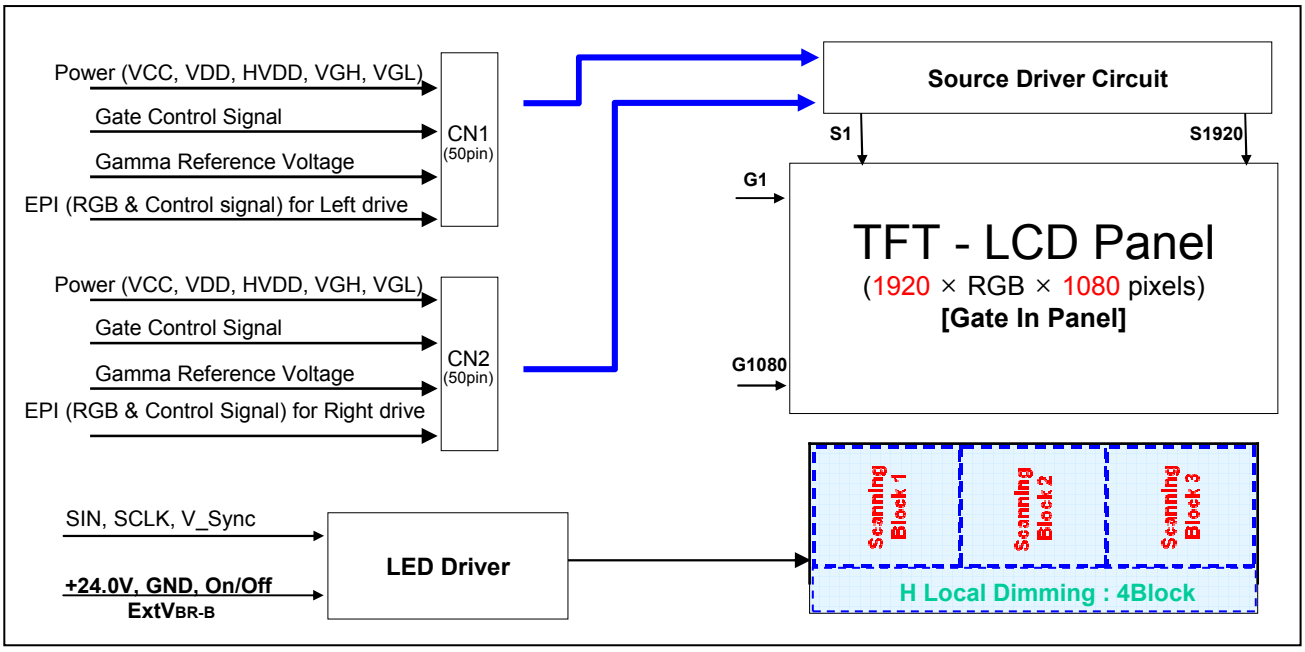
RECORD OF REVISIONS

Revision No.	Revision Date	Page	Description
0.0	Aug, 20, 2012	-	Preliminary Specification (First Draft)
0.1	Oct, 25, 2012		Update Electrical spec
1.0	Dec, 28, 2012		CAS Version 1.0 Release

1. General Description

The LC320EUA is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element.
It is a transmissive display type which is operating in the normally black mode. It has a 31.55 inch diagonally measured active display area with WUXGA resolution (1080 vertical by 1920 horizontal pixel array).
Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arrayed in vertical stripes.
Gray scale or the luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot.
Therefore, it can present a palette of more than 16.7Milion colors.
It is intended to support LCD TV, PCTV where high brightness, super wide viewing angle, high color gamut, high color depth and fast response time are important.



General Features

Active Screen Size	31.55 inches(801.31mm) diagonal
Outline Dimension	715.8 (H) × 416.33(V) X 9.7(B)/21.9 mm(D) (Typ.)
Pixel Pitch	0.36375 mm x 0.36375 mm
Pixel Format	1920 horiz. by 1080 vert. Pixels, RGB stripe arrangement
Color Depth	8-bit, 16.7 M colors (※ 1.06B colors @ 10 bit (D) System Output)
Drive IC Data Interface	Source D-IC : 8-bit EPI, gamma reference voltage, and control signals Gate D-IC : Gate In Panel
Luminance, White	350 cd/m^2 (Center 1point ,Typ.)
Viewing Angle (CR>10)	Viewing angle free (R/L 178 (Min.), U/D 178 (Min.))
Power Consumption	Total 43.6W (Typ.) [Logic= 6.2W, LED Driver=37.4W (ExtVbr_B=100%)]
Weight	5.0 Kg (Typ.)
Display Mode	Transmissive mode, Normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment : Haze 1%(typ.)

2. Absolute Maximum Ratings

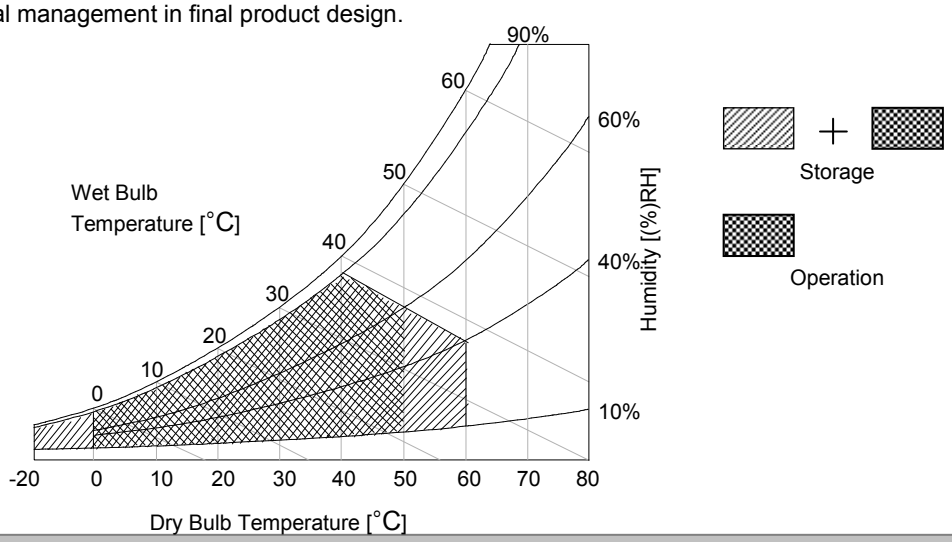
The following items are maximum values which, if exceeded, may cause faulty operation or permanent damage to the LCD module.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Value		Unit	Note
			Min	Max		
Logic & EPI Power Voltage		VCC	-0.5	+2.2	VDC	1
Gate High Voltage		VGH	+18.0	+30.0	VDC	
Gate Low Voltage		VGL	-8.0	-4.0	VDC	
Source D-IC Analog Voltage		VDD	-0.3	+18.0	VDC	
Gamma Ref. Voltage (Upper)		VGMH	½VDD-0.5	VDD+0.5	VDC	
Gamma Ref. Voltage (Low)		VGML	-0.3	½ VDD+0.5	VDC	
Driver Power Input Voltage		VBL	-0.3	+ 27.0	VDC	
Driver Control Voltage	ON/OFF	VOFF / VON	-0.3	+3.9	VDC	
	Brightness	**EXTV**BR-B	-0.3	+3.9	VDC	
	Status	**Status**	-0.3	+5.5	VDC	
Panel Front Temperature		TSUR	-	+68	°C	4
Operating Temperature		TOP	0	+50	°C	2,3
Storage Temperature		TST	-20	+60	°C	
Operating Ambient Humidity		HOP	10	90	%RH	
Storage Humidity		HST	10	90	%RH	

Note 1. Ambient temperature condition (Ta = 25 ± 2 °C)

2. Temperature and relative humidity range are shown in the figure below.
   Wet bulb temperature should be Max 39°C, and no condensation of water.
3. Gravity mura can be guaranteed below 40°C condition.
4. The maximum operating temperatures is based on the test condition that the surface temperature of display area is less than or equal to 68°C with LCD module alone in a temperature controlled chamber. Thermal management should be considered in final product design to prevent the surface temperature of display area from being over 68℃. The range of operating temperature may be degraded in case of improper thermal management in final product design.



3. Electrical Specifications

3-1. Electrical Characteristics

It requires several power inputs. The VCC is the basic power of LCD Driving power sequence, Which is used to logic power voltage of Source D-IC and GIP.

Table 2. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	MIN	TYP	MAX	Unit	Note
Logic & EPI Power Voltage	VCC	-	1.62	1.8	1.98	VDC	
Logic High Level Input Voltage	VIH	-	1.4	-	VCC	VDC	
Logic Low Level Input Voltage	VIL	-	0	-	0.4	VDC	
Source D-IC Analog Voltage	VDD	-	16.8	17	17.2	VDC	
Half Source D-IC Analog Voltage	H_VDD	-	8.3	8.5	8.7	VDC	6
Gamma Reference Voltage	V_{GMH}	(GMA1 ~ GMA9)	H_VDD+0.2V	-	VDD-0.2	VDC	
	V_{GML}	(GMA10 ~ GMA18)	0.2	-	H_VDD-0.2V	VDC	
Common Voltage	Vcom	Reverse	7.0	7.3	7.6	V	
EPI input common voltage	VCM	LVDS Type	0.8	VCC/2	1.3	V	5
EPI input differential voltage	Vdiff	-	150	-	500	mV	
EPI Input eye diagram	Veye	-	90	-	-	mV	
Gate High Voltage	VGH	@ 25℃	26.7	27	27.3	VDC	
		@ 0℃	28.7	29	29.3	VDC	
Gate Low Voltage	VGL	–	-5.2	-5.0	-4.8	VDC	
GIP Bi-Scan Voltage	VGI_P	-	VGL	-	-	VDC	
	VGI_N	-	-	-	VGH	VDC	
GIP Refresh Voltage	VGH even/odd	-	VGL	-	VGH	V	
GIP Start Pulse Voltage	VST	-	VGL	-	VGH	V	
GIP Operating Clock	GCLK	-	VGL	-	VGH	V	
Total Power Current	ILCD	-	-	520	650	mA	1
Total Power Consumption	PLCD	-	-	6.2	7.8	Watt	1

Note:

1. The specified current and power consumption are under the V_{LCD}=12V., 25 ± 2°C, f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The above spec is based on the basic model.
3. All of the typical gate voltage should be controlled within 1% voltage level
4. Ripple voltage level is recommended under ±5% of typical voltage
5. In case of EPI signal spec, refer to Fig 2 for the more detail.
6. HVDD Voltage level is half of VDD and it should be between Gamma9 and Gamma10.

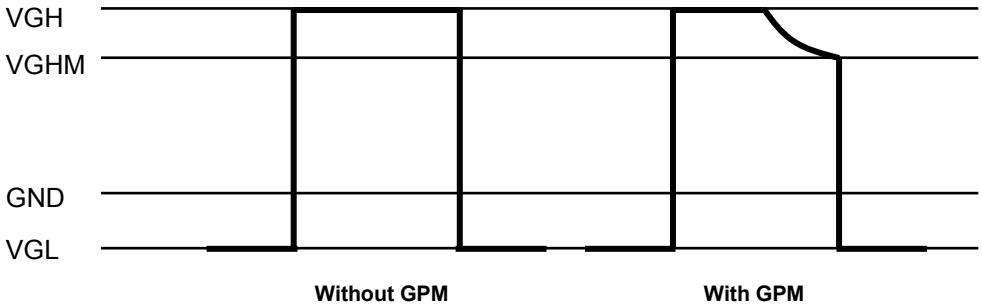


FIG. 1 Gate Output Wave form without GPM and with GPM

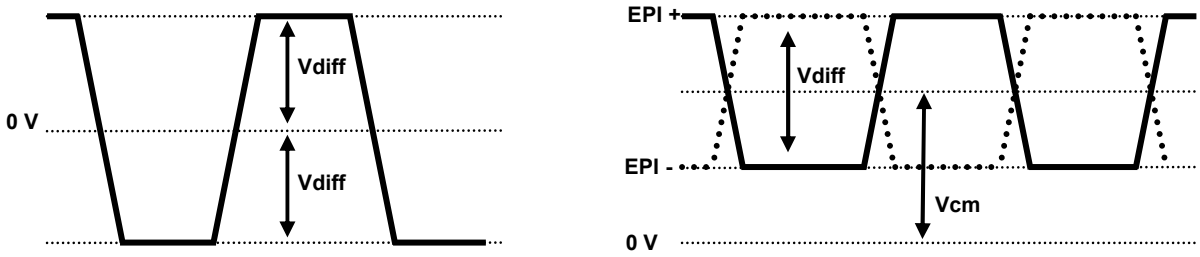


FIG. 2-1 EPI Differential signal characteristics

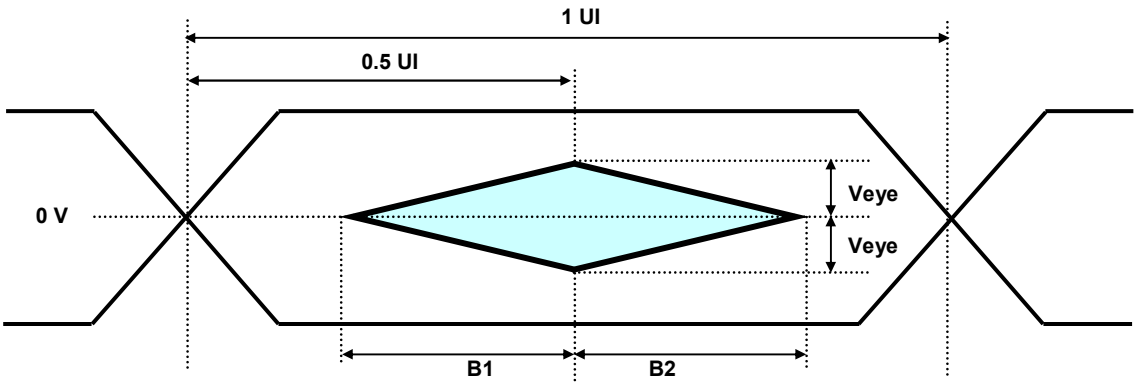


FIG. 2-2 Eye Pattern of EPI Input

*Source PCB

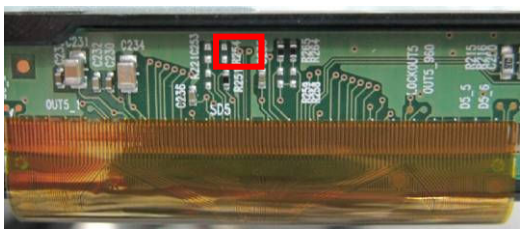


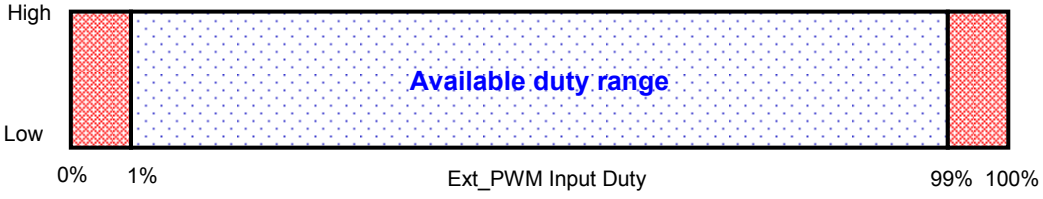
FIG. 3 Measure point

Table 3. ELECTRICAL CHARACTERISTICS (Continue)

Parameter			Symbol	Values			Unit	Notes
				Min	Typ	Max		
LED Driver :								
Power Supply Input Voltage			VBL	22.8	24.0	25.2	Vdc	1
Power Supply Input Current			IBL	-	1.56	1.74	A	1
Power Supply Input Current (In-Rush)			In-rush	-	-	3	A	V_{BL} = 22.8V Ext V_{BR-B} = 100% 4
Power Consumption			PBL	-	37.4	39.7	W	1
Input Voltage for Control System Signals	On/Off	On	V on	2.5	-	3.6	Vdc	
		Off	V off	-0.3	0.0	0.7	Vdc	
	Brightness Adjust		ExtVBR-B	1	-	100	%	On Duty 6
	PWM Frequency for NTSC & PAL		PAL		100		Hz	3
			NTSC		120		Hz	3
	Pulse Duty Level (PWM)		High Level	2.5	-	3.6	Vdc	HIGH : on duty LOW : off duty
			Low Level	0.0	-	0.7	Vdc	
	VSYNC, SIN, SCLK (Local Dimming)		High Level	2.7	3.3	3.6	Vdc	
			Low Level	-0.3	0.0	0.4	Vdc	
LED :								
Life Time				30,000	50,000		Hrs	2

Notes :

1. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 60 minutes at 25±2°C. The specified current and power consumption are under the typical supply Input voltage 24Vand V_{BR} (ExtV_{BR-B} : 100%), it is total power consumption.
2. The life time (MTTF) is determined as the time which luminance of the LED is 50% compared to that of initial value at the typical LED current (ExtVBR-B :100%) on condition of continuous operating in LCM state at 25±2°C.
3. LGD recommend that the PWM freq. is synchronized with One time harmonic of V_sync signal of system. Though PWM frequency is over 120Hz (max 252Hz), function of LED Driver is not affected.
4. The duration of rush current is about 200ms. This duration is applied to LED on time.
5. Even though inrush current is over the specified value, there is no problem if I^2T spec of fuse is satisfied.
6. Ext_PWM Signal have to input available duty range.
   Between 99% and 100% ExtV_{BR-B} duty have to be avoided. (99% < ExtV_{BR-B} < 100%)
   But ExtV_{BR-B} 0% and 100% are available.



3-2. Interface Connections

This LCD module employs two kinds of interface connection, two 50-pin FFC connector are used for the module electronics and 8-pin / 8-pin connectors are used for the integral backlight system.

3-2-1. LCD Module

-LCD Connector (CN1): TF06L-50S-0.5SH (Manufactured by HRS) or Compatible

Table 3-1. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	LTD_OUT	LTD OUTPUT	26	GND	Ground
2	NC	No Connection	27	EPI2-	EPI Receiver Signal(2-)
3	GCLK1	GIP GATE Clock 1	28	EPI2+	EPI Receiver Signal(2+)
4	GCLK2	GIP GATE Clock 2	29	GND	Ground
5	GCLK3	GIP GATE Clock 3	30	GND	Ground
6	GCLK4	GIP GATE Clock 4	31	EPI1-	EPI Receiver Signal(1-)
7	GCLK5	GIP GATE Clock 5	32	EPI1+	EPI Receiver Signal(1+)
8	GCLK6	GIP GATE Clock 6	33	GND	Ground
9	VGI_N	GIP Bi-Scan (VGI_N = VGH)	34	VCC	Logic & EPI Power Voltage
10	VGI_P	GIP Bi-Scan (VGI_P = VGL)	35	NC	No Connection
11	VGH_ODD	GIP Panel VDD for Odd GATE TFT	36	LOCKOUT3	LOCKOUT3
12	VGH_EVEN	GIP Panel VDD for Even GATE TFT	37	NC	No Connection
13	VGL	GATE Low Voltage	38	GND	Ground
14	VST	VERTICAL START PULSE	39	GMA18	GAMMA VOLTAGE 18 (Output From LCD)
15	GIP_Reset	GIP Reset	40	NC	No Connection
16	VCOM_L_FB	VCOM Left Feed-Back Output	41	GMA 15	GAMMA VOLTAGE 15
17	VCOM_L	VCOM Left Input	42	GMA 14	GAMMA VOLTAGE 14
18	GND	Ground	43	GMA 12	GAMMA VOLTAGE 12
19	VDD	Driver Power Supply Voltage	44	GMA 10	GAMMA VOLTAGE 10 (Output From LCD)
20	VDD	Driver Power Supply Voltage	45	GMA 1	GAMMA VOLTAGE 1 (Output From LCD)
21	H_VDD	Half Driver Power Supply Voltage	46	GMA 4	GAMMA VOLTAGE 4
22	GND	Ground	47	GMA 5	GAMMA VOLTAGE 5
23	EPI3-	EPI Receiver Signal(3-)	48	GMA 7	GAMMA VOLTAGE 7
24	EPI3+	EPI Receiver Signal(3+)	49	NC	No Connection
25	GND	Ground	50	GMA 9	GAMMA VOLTAGE 9 (Output From LCD)

Note :

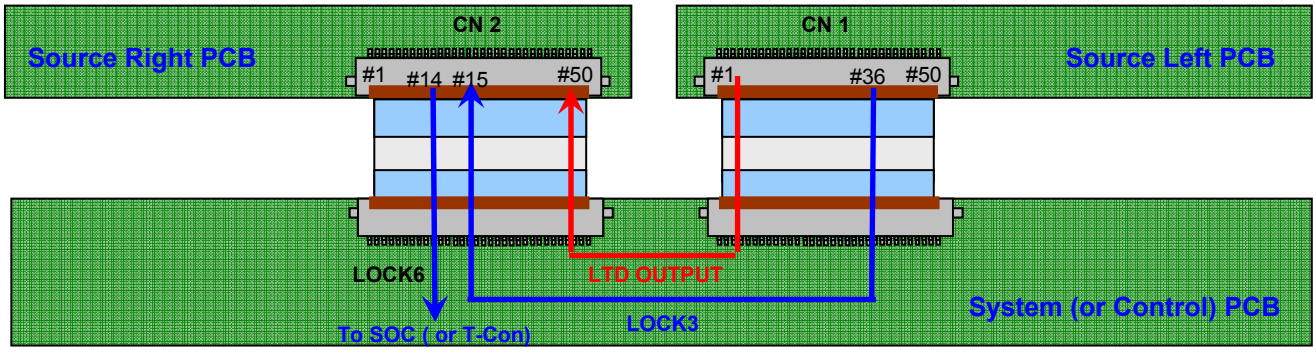
1. Please refer to application note for details.
(**GIP** & **Half VDD & Gamma Voltage setting**)

-LCD Connector (CN1): TF06L-50S-0.5SH (Manufactured by HRS) or Compatible

Table 3-2. MODULE CONNECTOR(CN2) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	GMA 9	GAMMA VOLTAGE 9 (Output From LCD)	26	GND	Ground
2	NC	No Connection	27	EPI1-	EPI Receiver Signal(4-)
3	GMA 7	GAMMA VOLTAGE 7	28	EPI1+	EPI Receiver Signal(4+)
4	GMA 5	GAMMA VOLTAGE 5	29	GND	Ground
5	GMA 4	GAMMA VOLTAGE 4	30	H_VDD	Half Driver Power Supply Voltage
6	GMA 1	GAMMA VOLTAGE 1 (Output From LCD)	31	VDD	Driver Power Supply Voltage
7	GMA 10	GAMMA VOLTAGE 10 (Output From LCD)	32	VDD	Driver Power Supply Voltage
8	GMA 12	GAMMA VOLTAGE 12	33	GND	Ground
9	GMA 14	GAMMA VOLTAGE 14	34	VCOM_R	VCOM Right Input
10	GMA 15	GAMMA VOLTAGE 15	35	VCOM_R_FB	VCOM Right Feed-Back Output
11	NC	No Connection	36	GIP_Reset	GIP Reset
12	GMA 18	GAMMA VOLTAGE 18 (Output From LCD)	37	VST	VERTICAL START PULSE
13	GND	Ground	38	VGL	GATE Low Voltage
14	LOCKOUT6	LOCKOUT6	39	VGH_EVEN	GIP Panel VDD for Even GATE TFT
15	LOCKIN3	LOCKIN3	40	VGH_ODD	GIP Panel VDD for Odd GATE TFT
16	NC	No Connection	41	VGI_P	GIP Bi-Scan (VGI_P = VGL)
17	VCC	Logic & EPI Power Voltage	42	VGI_N	GIP Bi-Scan (VGI_N = VGH)
18	GND	Ground	43	GCLK6	GIP GATE Clock 6
19	EPI6-	EPI Receiver Signal(6-)	44	GCLK5	GIP GATE Clock 5
20	EPI6+	EPI Receiver Signal(6+)	45	GCLK4	GIP GATE Clock 4
21	GND	Ground	46	GCLK3	GIP GATE Clock 3
22	GND	Ground	47	GCLK2	GIP GATE Clock 2
23	EPI5-	EPI Receiver Signal(5-)	48	GCLK1	GIP GATE Clock 1
24	EPI5+	EPI Receiver Signal(5+)	49	NC	No Connection
25	GND	Ground	50	LTD_OUT	LTD OUTPUT

Note : 1. Please refer to application note for details.
(**GIP** & **Half VDD & Gamma Voltage setting**)



3-2-2. Backlight Module

Master

-LED Driver Connector

: 20022WR - H14B2(Yeonho)

- Mating Connector

: 20022HS - 14B2 or compatible

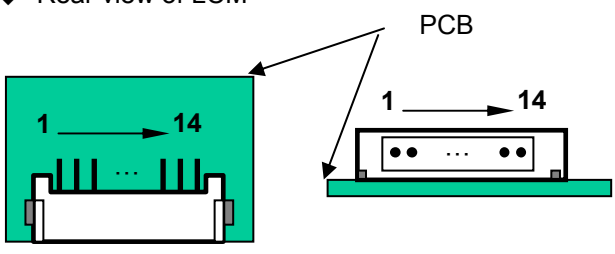
Table 4-1. LED DRIVER CONNECTOR PIN CONFIGURATION

Pin No	Symbol	Description	Note
1	V_{BL}	Power Supply +24.0V	
2	V_{BL}	Power Supply +24.0V	
3	V_{BL}	Power Supply +24.0V	
4	V_{BL}	Power Supply +24.0V	
5	V_{BL}	Power Supply +24.0V	
6	GND	Backlight Ground	
7	GND	Backlight Ground	
8	GND	Backlight Ground	1
9	GND	Backlight Ground	
10	GND	Backlight Ground	
11	Status	Back Light Status	2
12	$V_{ON/OFF}$	Backlight ON/OFF control	4
13	NC	Don't care	
14	EXTVBR-B	External PWM	3

Notes :1. GND should be connected to the LCD module's metal frame.

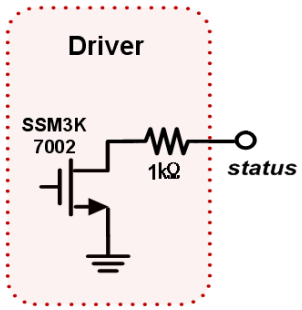
2. Normal : Low (under 0.7V) / Abnormal : Open
3. High : on duty / Low : off duty, Pin#14 can be opened. (if Pin #14 is open , EXTVBR-B is 100%)
4. Each impedance of pin #12 and 14 is over 50 [KΩ] .

◆ Rear view of LCM



<Master>

◆ Status



3-2-3. Local Dimming Interface

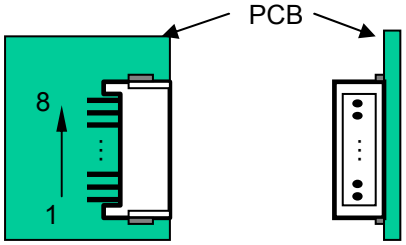
- Local Dimming Interface Connector : 12507WR-H08L(YEONHO Elec.)
- Mating Connector: 12507HS-08L(YEONHO Elec.)

Table 4-2. LOCAL DIMMING INTERFACE CONNECTOR PIN CONFIGULATION

Pin No	Symbol	Description	Note
1	VSYNC	Vertical Sync signal	2
2	N.C	Don't care	
3	N.C	Don't care	
4	SIN	Local Dimming Serial Data (SPI)	
5	GND	Backlight Ground	1
6	SCLK	Local Dim Serial Clock (SPI)	
7	N.C	Don't care	
8	N.C	Don't care	

Notes : 1. GND should be connected to the LCD module's metal frame.
2. Vertical Sync Freq. should be double of frame rate (Vf = 60Hz → Vsync 120Hz)

◆ Rear view of LCM



3-3. Signal Timing Specifications

Table 5. Timing Requirements

Parameter	Symbol	Condition	Min	Typ	Max	Unit	notes
Unit Interval	UI	-	1.37	1.44	1.70	ns	
Effective Veye width time	B1&B2	-	0.25	-	-	UI	Fig. 2
Modulation Ratio of SSC	Vspread	@100KHz	-	-	2	%	1
1st data to SOE rising time	Ts1	-	3	-	-	Packet	Fig.4
SOE rising to last data	Ts4		0	-	-	Packet	Fig.4
Last data to SOE falling	Ts5	-	10	-	-	Packet	Fig.4
EPI Bandwidth	BW	-	0.588	-	0.728	GBPS	

notes : 1. VModulation Ratio of SSC for 20KHz ~ 100kHz Modulation Frequency is calculated by (7 – 0.05*Fmod), where Fmod unit is KHz.

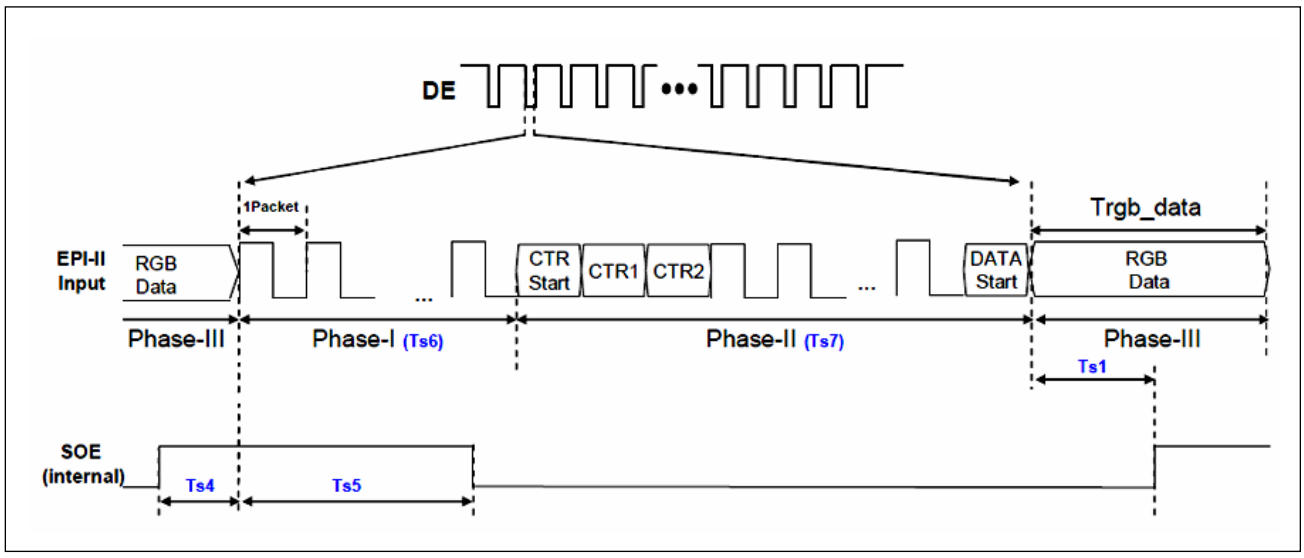


FIG 4. SOE Width & Timing

3-4. Panel Pixel Structure

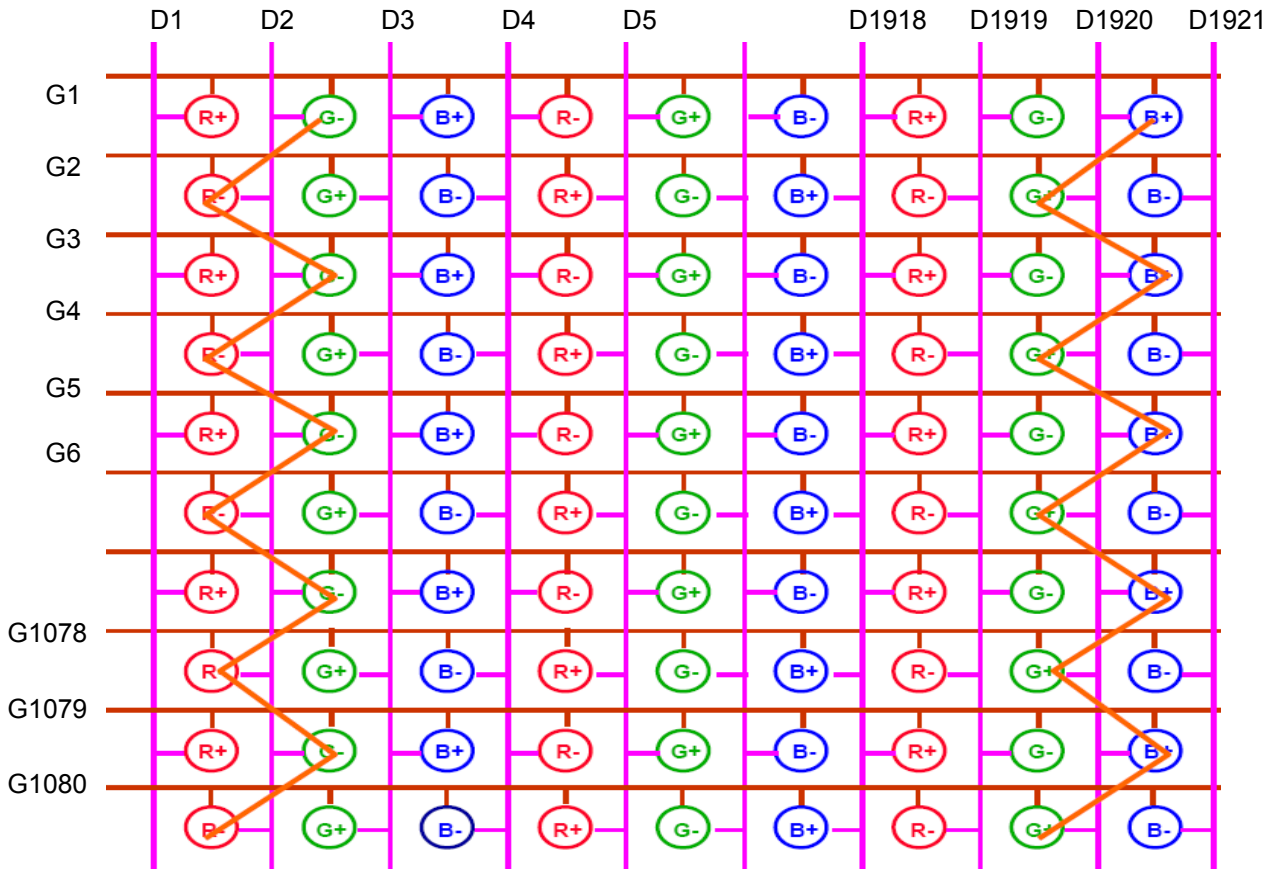


FIG. 5 Panel Pixel Structure

3-5. Power Sequence

3-5-1. LCD Driving circuit

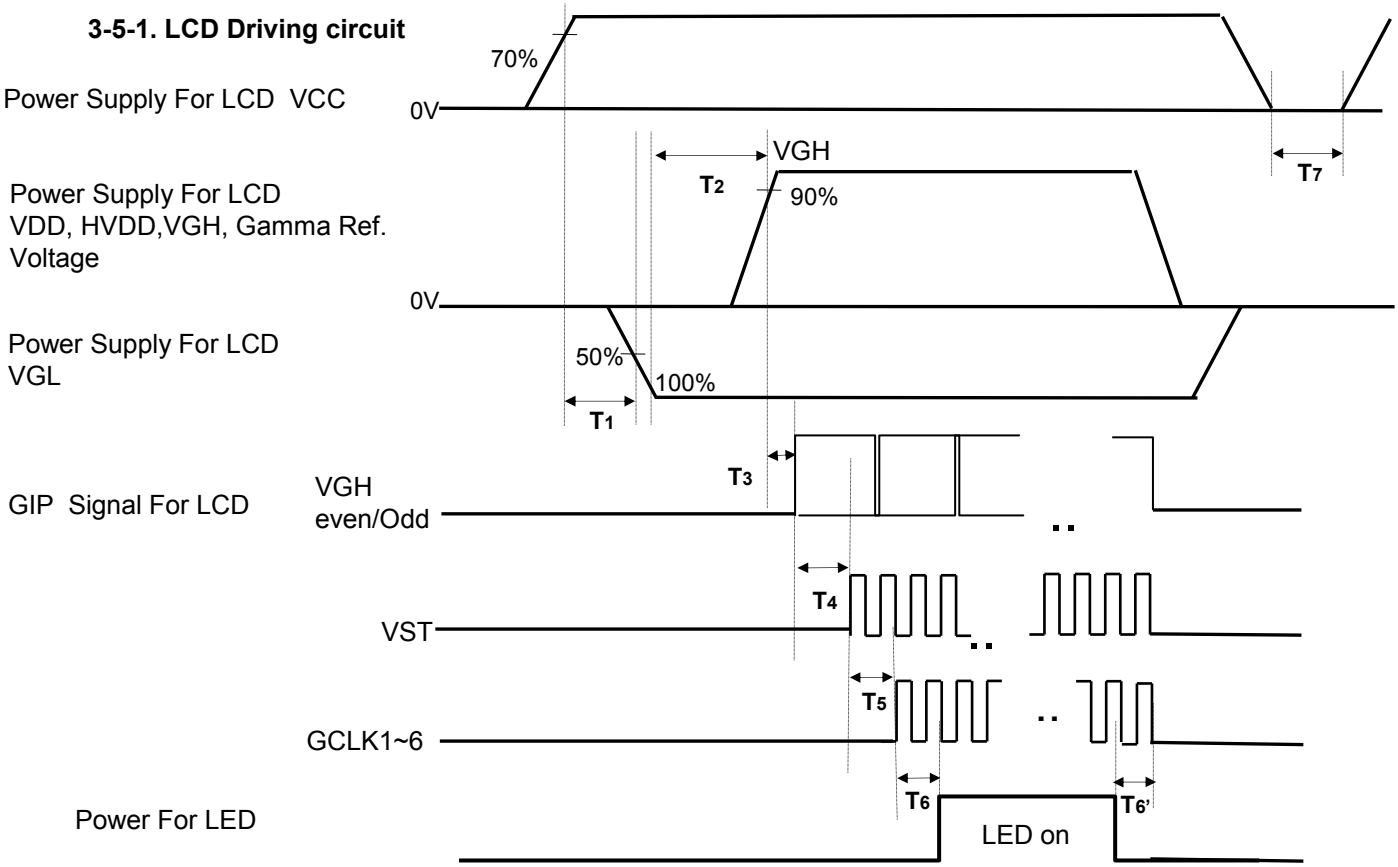


Table 6. POWER SEQUENCE

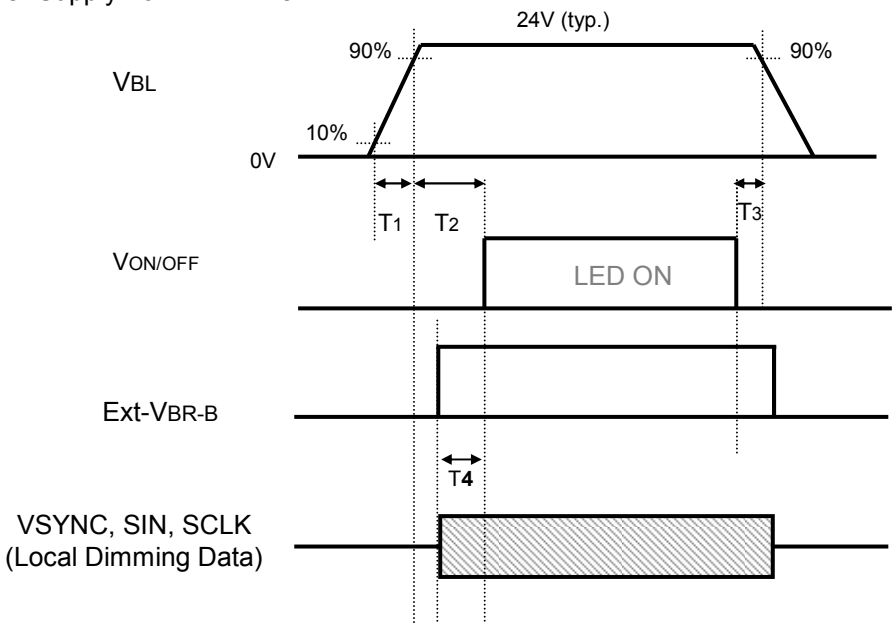
Ta= 25±2°C, fv=60Hz,

Parameter	Value			Unit	Notes
	Min	Typ	Max		
T_1	0.5	-	-	ms	
T_2	0.5	-	-	ms	
T_3	0	-	-	ms	
T_4	10	-	-	ms	2
T_5	0	-	-	ms	
T_6 / T_6'	20	-	-	ms	6
T_7	2	-	-	s	

Note : 1. Power sequence for Source D-IC must follow the Case1 & 2.
※ Please refer to Appendix IV for more details.
2. VGH even & odd can not be "High at the same time.
3. Power Off Sequence order is reverse of Power On Condition including Source D-IC.
4. GCLK On/Off Sequence
:GCLK3 → GCLK2 →GCLK1 → GCLK6 → GCLK5 → GCLK4.
5. VDD_odd/even transition time should be within V_blank
6. In case of T6', If there is no abnormal display, no problem

3-5-2. Sequence for LED Driver

Power Supply For LED Driver



3-5-3. Dip condition for LED Driver

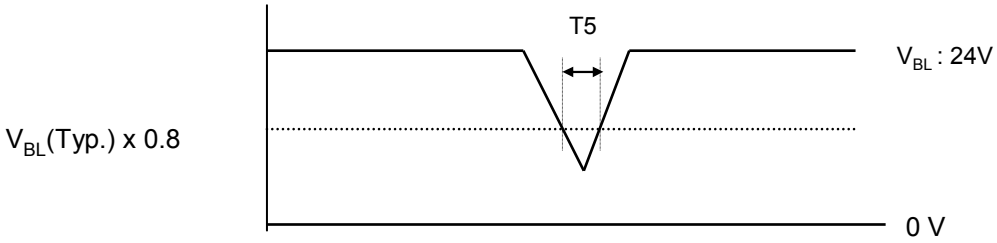


Table 7. Power Sequence for LED Driver

Parameter	Values			Units	Remarks
	Min	Typ	Max		
T1	20	-	-	ms	1
T2	500	-	-	ms	
T3	10	-	-	ms	
T4	0	-	-	ms	
T5	-	-	10	ms	V_{BL}(Typ) x 0.8

notes : 1. T1 describes rising time of 0V to 24V and this parameter does not applied at restarting time.
Even though T1 is over the specified value, there is no problem if I^2T spec of fuse is satisfied.

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable in a dark environment at 25±2°C. The values are specified at 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 °.
FIG. 9 shows additional information concerning the measurement equipment and method.

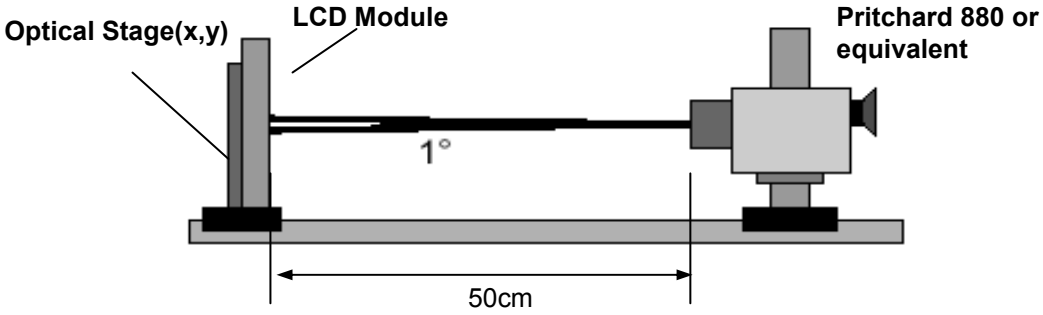


FIG. 9 Optical Characteristic Measurement Equipment and Method

Table 8. OPTICAL CHARACTERISTICS

Ta= 25±2°C, VDD,H_VDD,VGH,VGL=typ, fv=60Hz, BW=0.693GBPS, IF = 150mA

Parameter			Symbol		Value Min	Value Typ	Value Max	Unit	Note
Contrast Ratio			CR		1000	1400	-		1
Surface Luminance, white			L_{WH}	2D	280	350		cd/m²	2
				3D	105	130			6
Luminance Variation			δ_{WHITE}	9P	60	70		%	3
Response Time		Rising	Tr		-	8	12	ms	4
		Falling	Tf		-	10	14		
Color Coordinates [CIE1931]		RED	Rx		Typ -0.03	0.646	Typ +0.03		
			Ry			0.336			
		GREEN	Gx			0.300			
			Gy			0.621			
		BLUE	Bx			0.154			
			By			0.058			
		WHITE	Wx			0.281			
			Wy			0.288			
Color Temperature						10,000		K	
Color Gamut						68		%	
Viewing Angle	2D (CR>10)	right(ϕ=0°)	θr (x axis)		89	-	-	degree	5
		left (ϕ=180°)	θl (x axis)		89	-	-		
		up (ϕ=90°)	θu (y axis)		89	-	-		
		down (ϕ=270°)	θd (y axis)		89	-	-		
	3D (CT≤10%)	up + down	θu (y axis) +θd (y axis)		16	20	-	degree	7
		up	θu (y axis)		5	-	-	degree	
		down	θd (y axis)		5	-	-	degree	
3D Crosstalk			3D C/T		-	1	3	%	
Gray Scale					-	-	-		6

Note : 1. Contrast Ratio(CR) is defined mathematically as :

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

It is measured at center 1-point.

2. Surface luminance is determined after the unit has been 'ON' and 1 Hour after lighting the backlight in a dark environment at 25±2°C. Surface luminance is the luminance value at center 1-point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see the FIG. 10.

3.The variation in surface luminance , δ WHITE is defined as :
δ WHITE(9P) = Minimum(L_{on1},L_{on2}, … , L_{on8}, L_{on9}) / Maximum(L_{on1},L_{on2}, … , L_{on8}, L_{on9})*100
Where L_{on1} to L_{on9} are the luminance with all pixels displaying white at 9 locations .
For more information, see the FIG. 10.

4. Response time is the time required for the display to transit from G(255) to G(0) (Rise Time, Tr_R) and from G(0) to G(255) (Decay Time, Tr_D). For additional information, see the FIG. 11.

5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD module surface. For more information, see the FIG. 12.

6. Gray scale specification
Gamma Value is approximately 2.2. For more information, see the Table 9.

7. 3D performance specification is expressed by 3D luminance, 3D Crosstalk and 3D viewing angle. 3D luminance and 3D crosstalk is measured at center 1-point.
For more information, see the FIG 13~16.

Table 9. GRAY SCALE SPECIFICATION

Gray Level	Luminance [%] (Typ)
L0	0.07
L15	0.27
L31	1.04
L47	2.49
L63	4.68
L79	7.66
L95	11.5
L111	16.1
L127	21.6
L143	28.1
L159	35.4
L175	43.7
L191	53.0
L207	63.2
L223	74.5
L239	86.7
L255	100

	Gray Level	Gamma Ref.
Positive Voltage	L0	Gamma9
	L1	Gamma8
	L31	Gamma7
	L63	Gamma6
	L127	Gamma5
	L191	Gamma4
	L223	Gamma3
	L255	Gamma1
Negative Voltage	L255	Gamma18
	L223	Gamma16
	L191	Gamma15
	L127	Gamma14
	L63	Gamma13
	L31	Gamma12
	L1	Gamma11
	L0	Gamma10

Measuring point for surface luminance & measuring point for luminance variation.

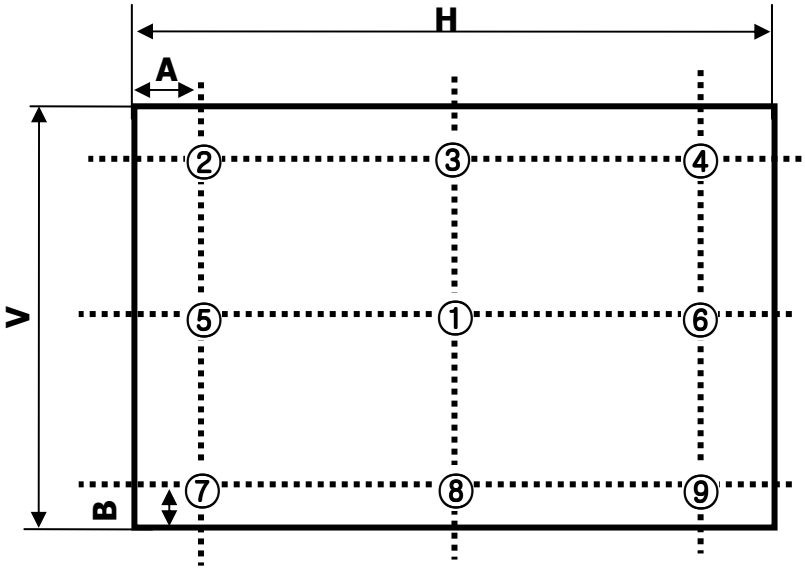


FIG. 10 9 Points for Luminance Measure

Response time is defined as the following figure and shall be measured by switching the input signal for "Black" ~ "White" and "White" ~ "Black".

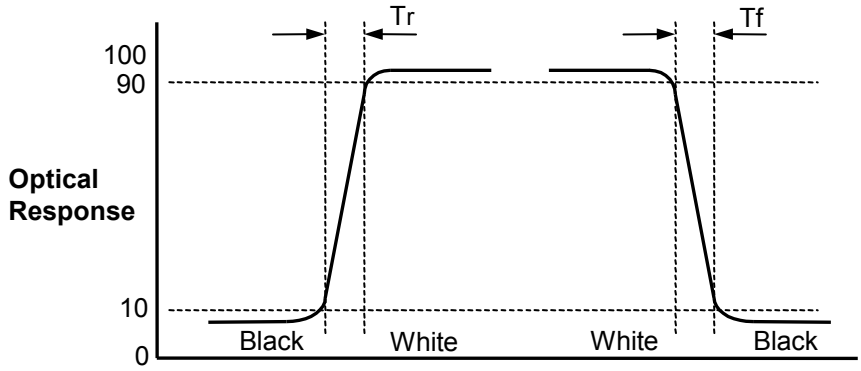


FIG. 11 Response Time

Dimension of viewing angle range

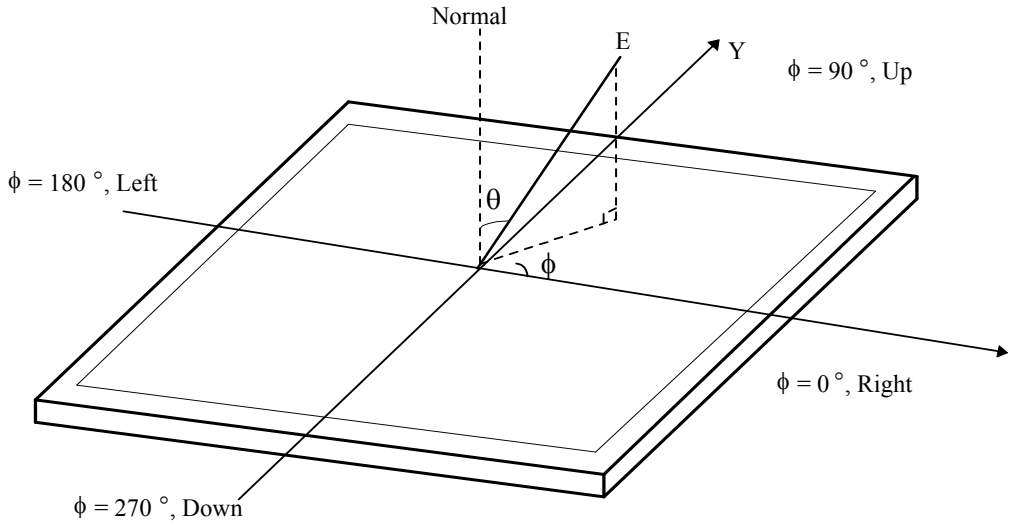
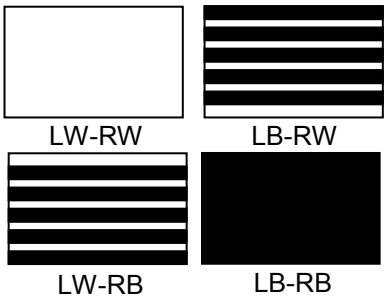
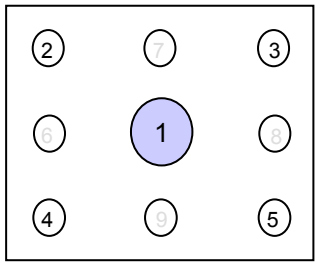


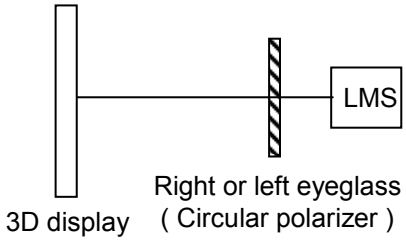
FIG. 12 Viewing Angle



(a) Test pattern image

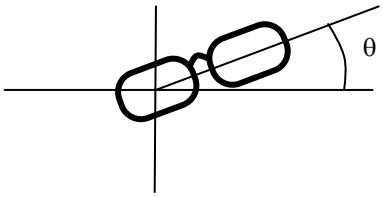


(b) Measurement position

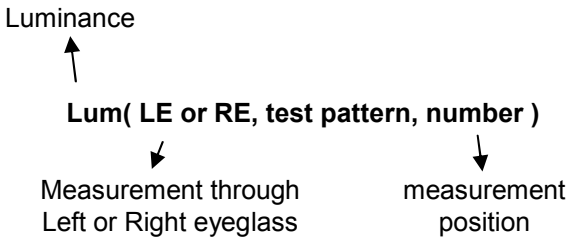


(c) Setup

< FIG. 13. Measurement configuration>



< FIG. 14. Positioning eyeglass >



< FIG. 15. notation of luminance measurement >

In order to measure 3D luminance, 3D crosstalk and 3D viewing angle, it need to be prepared as below;

1) Measurement configuration

4-Test pattern images. Refer to FIG 13.

-. LW-RW : White for left and right eye

-. LW-RB : White for left eye and Black for right eye

-. LB-RW : Black for left eye and white for right eye

-. LB-RB : Black for left eye and right eye

Image files where black and white lines are displayed on even or odd lines.

Luminance measurement system (LMS) with narrow FOV (field of view) is used. Refer to FIG 9.

2) Positioning Eyeglass (refer to appendix-VI for standard specification of eyeglass)

Find angle of minimum transmittance.

This value would be provided beforehand or measured by the following steps;

(i) Test image (LB-RW) is displayed.

(ii) Left eyeglass are placed in front of LMS and luminance is measured, rotating right eyeglass such as FIG 14. The notation for luminance measurement is “Lum(LE, LB-RW,1)”.

(iii) Find the angle where luminance is minimum.

* Following measurements should be performed at the angle of minimum transmittance of eyeglass.

3) Measurement of 3D luminance
(i) Test image (LW-RW) is displayed.
(ii) Left or right eyeglass are placed in front of LMS successively and luminance is measured at center 1 point where the notation for luminance measurement is "Lum(LE, LW-RW,1)" or "Lum(RE, LW-RW,1).

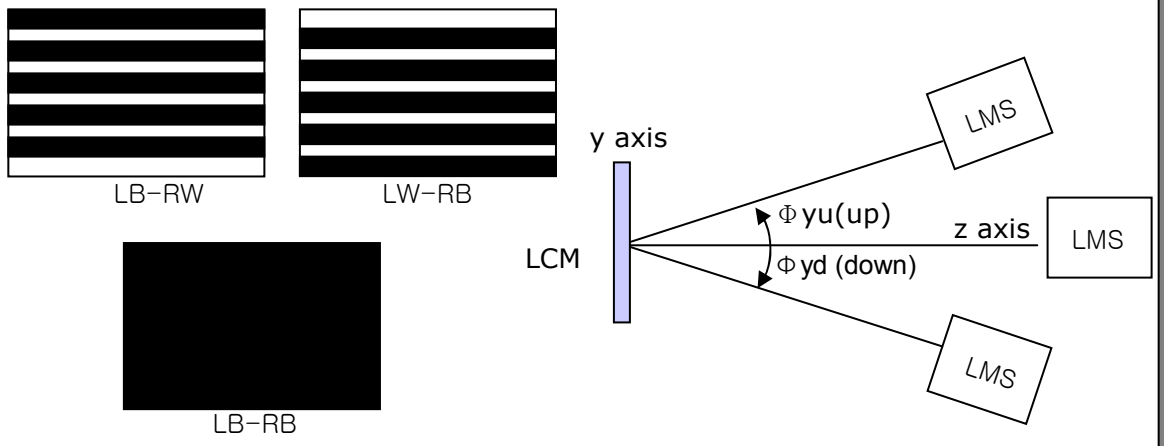
4) Measurement of 3D crosstalk
(i) Test image (LB-RW, LW-RB and LB-RB) is displayed.
(ii) Right or left eyeglass are placed in front of LMS successively and luminance is measured for position 1.
with rotating LMS or sample vertically.

$$\frac{\text{Lum(LE, LB-RW,1) - Lum(LE, LB-RB,1)}}{\text{Lum(LE, LW-RB,1) - Lum(LE, LB-RB,1)}}$$

or

$$\frac{\text{Lum(RE, LW-RB,1) - Lum(RE, LB-RB,1)}}{\text{Lum(RE, LB-RW,1) - Lum(RE, LB-RB,1)}}$$

5) Measurement of 3D Viewing Angle
3D viewing angle is the angle at which the 3D crosstalk is under 10%. The angles are determined for the vertical or y axis with respect to the z axis which is normal to the LCD module surface and measured for position 1. For more information , see the Fig 16



(a) Test pattern image (b) Measurement of 3D viewing angle (up/down)

< FIG. 16. Measurement of 3D crosstalk and 3D viewing angle >

5. Mechanical Characteristics

Table12 provides general mechanical characteristics.

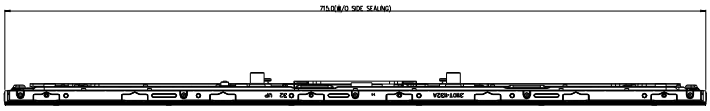
Table 12. MECHANICAL CHARACTERISTICS

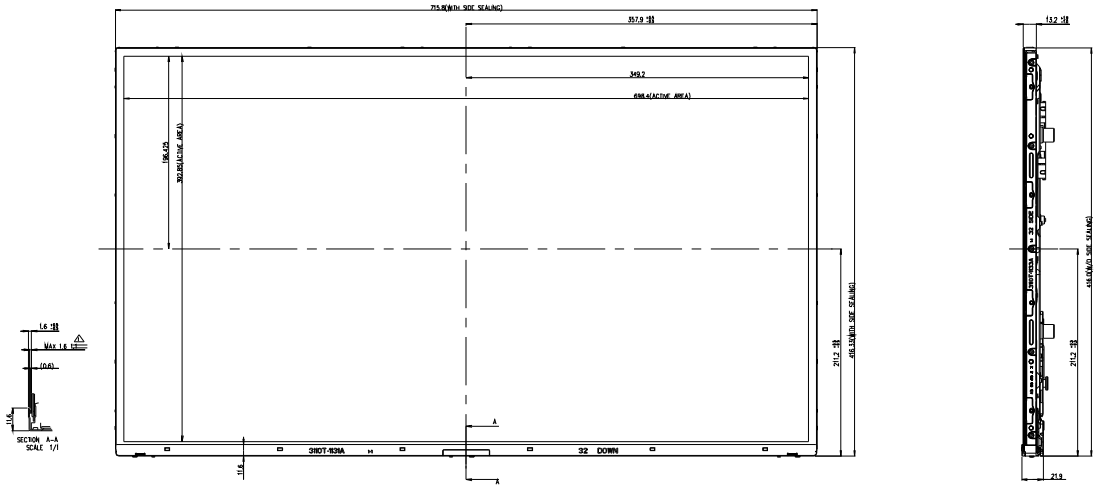
Item	Value	
Outline Dimension	Horizontal	715.8 mm
	Vertical	416.33 mm
	Depth	9.7mm(B), 21.9mm
Bezel Area	Horizontal	715.8 mm
	Vertical	404.73 mm
Active Display Area	Horizontal	698.4 mm
	Vertical	392.85 mm
Weight	5.0 Kg (Typ.), 5.3 kg (Max.)	

Note : Please refer to a mechanical drawing in terms of tolerance at the next page.

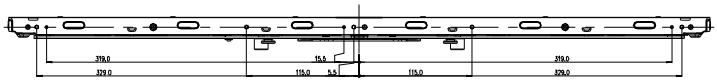
[FRONT VIEW]

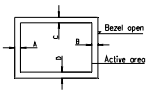
SET : TOP





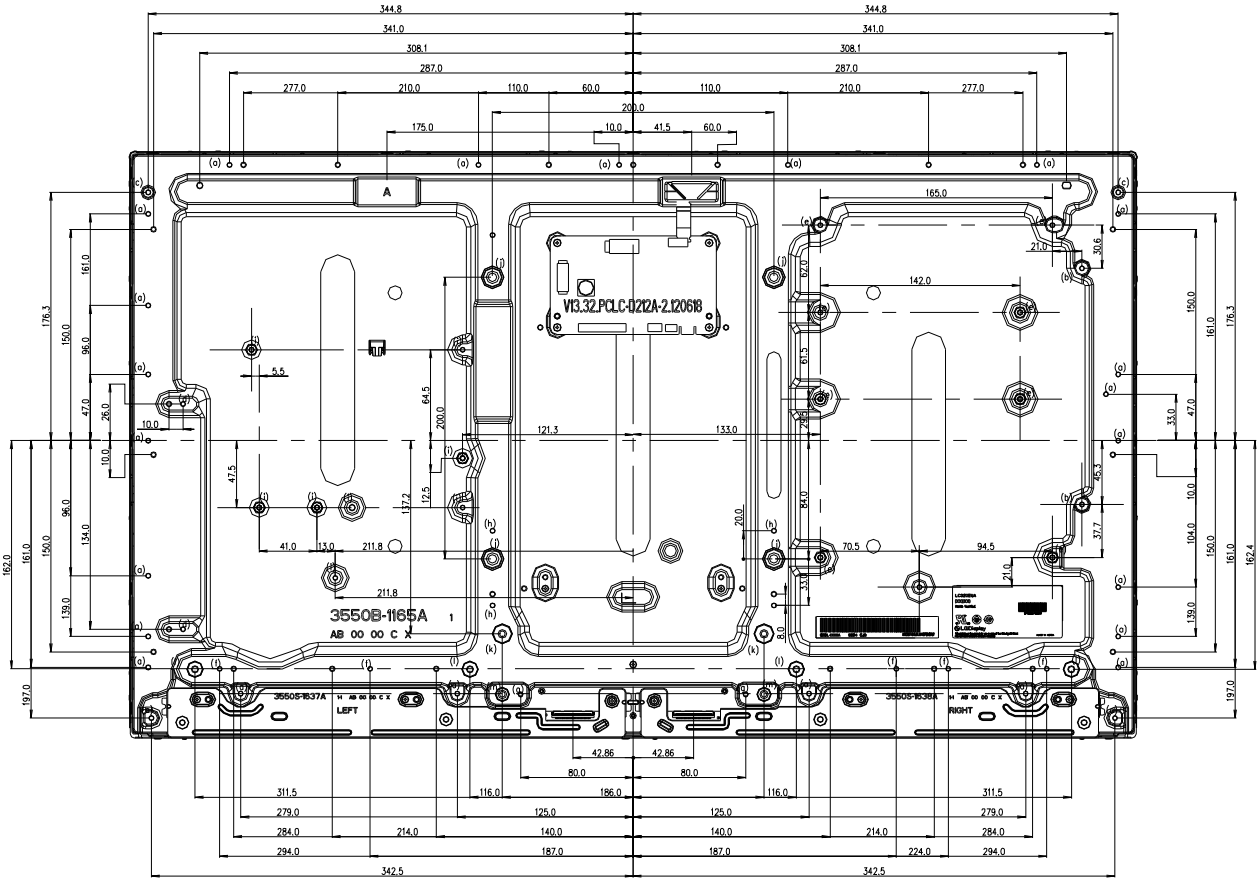
SET : DOWN





[REAR VIEW]

SET : TOP



SET : DOWN

ITEM	TAP	Max Depth (mm)	Torque (kgf.cm)	Notes
(a)	M3.0	3.5	Max 8.0	
(b)	M3.0	4.2	Max 8.0	
(c)	M3.0	4.5	Max 8.0	
(d)	M3.0	7.1	Max 8.0	
(e)	M3.0	8.2	Max 8.0	
(f)	M3.0	4.5	Max 8.0	
(g)	M3.0	2.8	Max 8.0	
(h)	M3.0	7.5	Max 8.0	
(i)	M3.0	4.0	Max 8.0	
(j)	M6.0	13.0	Max 15.0	
(k)	M4.0	8.5	Max 10.0	
(l)	M4.0	7.3	Max 10.0	
(m)	M4.0	6.5	Max 10.0	
(n)	M4.0	4.0	Max 10.0	

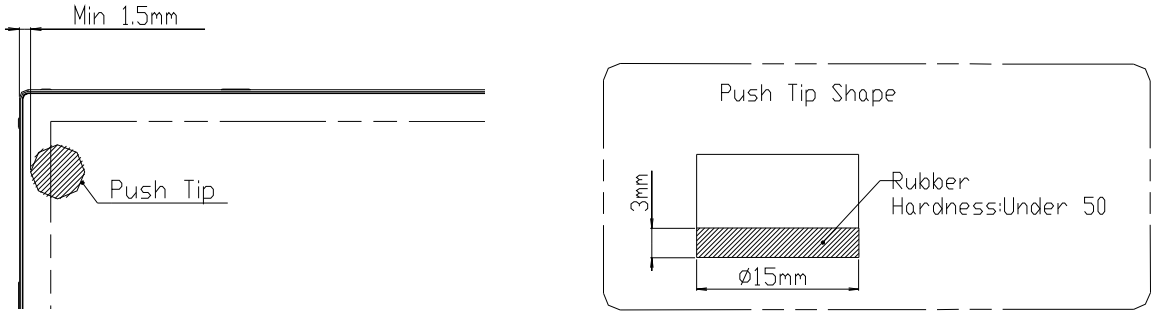
6. Reliability

Table 10. ENVIRONMENT TEST CONDITION

No.	Test Item	Condition
1	High temperature storage test	Ta= 60°C 240h
2	Low temperature storage test	Ta= -20°C 240h
3	High temperature operation test	Ta= 50°C 50%RH 240h
4	Low temperature operation test	Ta= 0°C 240h
5	Vibration test (non-operating)	No Guarantee
6	Shock test (non-operating)	No Guarantee
7	Panel Push Test (Module Condition)	Max 6kgf (Test Method : Note 2)
8	Humidity condition Operation	Ta= 40 °C ,90%RH
9	Altitude operating storage / shipment	0 - 16,400 ft 0 - 40,000 ft

Note 1 : Before and after Reliability test, LCM should be operated with normal function.

Note 2 : Panel Push Test Method



7. International Standards

7-1. Safety

a) UL 60065, Underwriters Laboratories Inc.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

b) CAN/CSA C22.2 No.60065:03, Canadian Standards Association.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

c) EN 60065, European Committee for Electrotechnical Standardization (CENELEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

d) IEC 60065, The International Electrotechnical Commission (IEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.
(Including report of IEC60825-1:2001 clause 8 and clause 9)

Notes

1. Laser (LED Backlight) Information

Class 1M LED Product IEC60825-1 : 2001 Embedded LED Power (Class1M)

2. Caution
: LED inside.
Class 1M laser (LEDs) radiation when open.
Do not open while operating.

7-2. EMC

a) ANSI C63.4 “American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.” American National Standards Institute (ANSI), 2003.

b) CISPR 22 “Information technology equipment – Radio disturbance characteristics – Limit and methods of measurement." International Special Committee on Radio Interference (CISPR), 2005.

c) CISPR 13 “Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and method of measurement." International Special Committee on Radio Interference (CISPR), 2006.

7-3. Environment

a) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

8. Packing

8-1. Information of LCM Label

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M

A,B,C : SIZE(INCH)
D : YEAR
E : MONTH
F ~ M : SERIAL NO.

Note

1. YEAR

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

b) Location of Lot Mark

Serial NO. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

8-2. Packing Form

a) Package quantity in one Pallet : 36 pcs

b) Pallet Size : 1140 mm(W) X 870 mm(D) X 1161 mm(H)

9. Precautions

Please pay attention to the followings when you use this TFT LCD module.

9-1. Mounting Precautions

(1) You must mount a module using specified mounting holes (Details refer to the drawings).
(2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
(3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to the resist external force.
(4) You should adopt radiation structure to satisfy the temperature specification.
(5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
(6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics are detrimental to the polarizer.)
(7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer
(8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(9) Do not open the case because inside circuits do not have sufficient strength.

9-2. Operating Precautions

(1) Response time depends on the temperature.(In lower temperature, it becomes longer.)
(2) Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer
(3) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
(4) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(5) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.
(6) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
(7) A screw which is fastened up the steels should be a machine screw.
(if not, it can causes conductive particles and deal LCM a fatal blow)
(8) Please do not set LCD on its edge.
(9) The conductive material and signal cables are kept away from LED driver inductor to prevent abnormal display, sound noise and temperature rising.

9-3. Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

9-4. Precautions for Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

9-5. Storage

When storing modules as spares for a long time, the following precautions are necessary.

(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
(2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.
(3) Storage condition is guaranteed under packing conditions.
(4) The phase transition of Liquid Crystal in the condition of the low or high storage temperature will be recovered when the LCD module returns to the normal condition

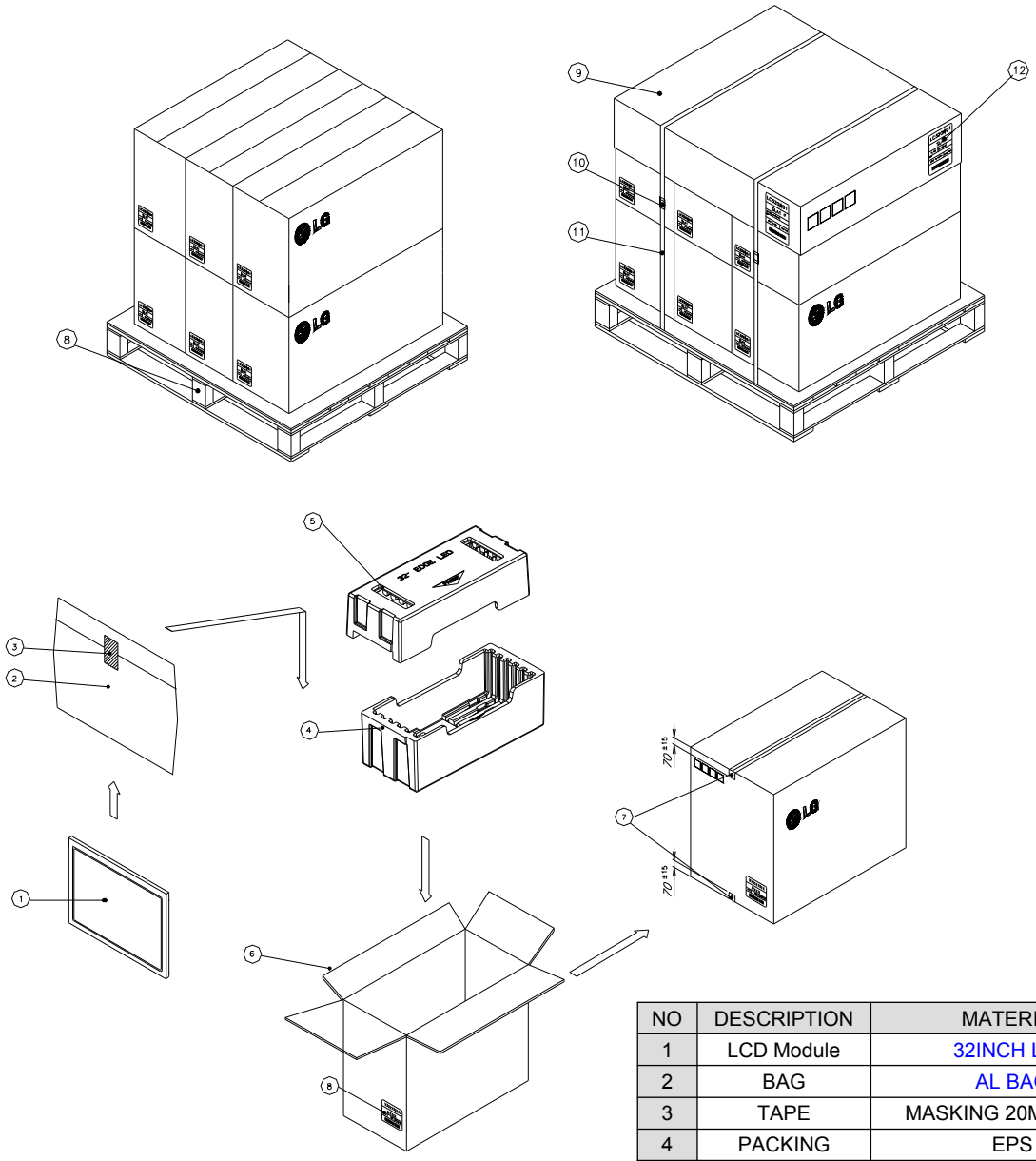
9-6. Operating condition guide

(1) The LCD product should be operated under normal conditions. Normal condition is defined as below;
- Temperature : 5 ~ 40 ℃, normal humidity.
- Display pattern : continually changing pattern (Not stationary)

(2) If the product will be used in extreme conditions such as high temperature, display patterns or operation time etc..,
It is strongly recommended to contact LGD for Qualification engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems. The LCD product should be applied by global standard environment. (refer ETSI EN 300, IEC 60721)

APPENDIX-I

■ Pallet Ass'y



NO	DESCRIPTION	MATERIAL
1	LCD Module	32INCH LCD
2	BAG	AL BAG
3	TAPE	MASKING 20MM X 50M
4	PACKING	EPS
5	PACKING	EPS
6	BOX	PAPER
7	TAPE	OPP
8	PALLET	Plastic (1140X870X120)
9	ANGLE COVER	PAPER
10	BAND,CLIP	STEEL
11	BAND	PP
12	LABEL	YUPO PAPER 80G 100X100

 # APPENDIX- II-1

■ LCM Label

■ Production site
- LG Display (Paju) Co., LTD

Note 1.The origin of LCM Label will be changed according to the production site.

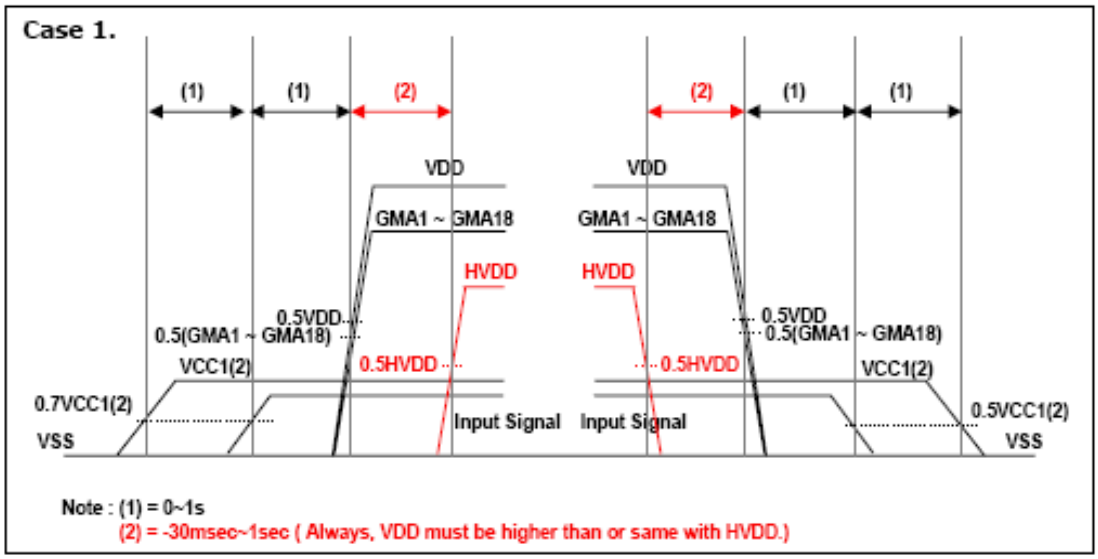
 # APPENDIX- II-2

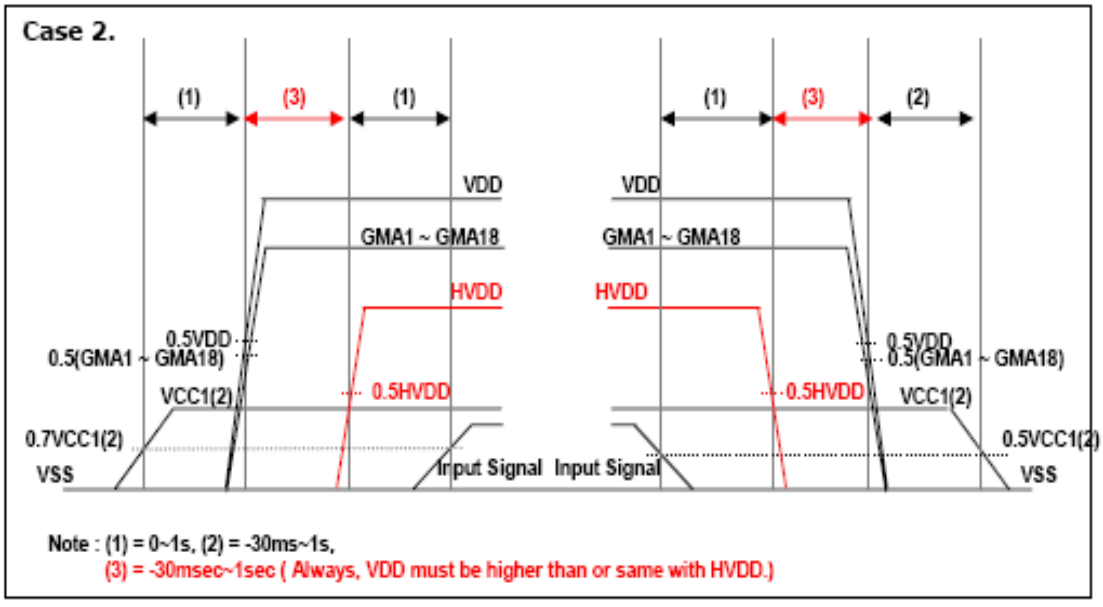
■ Box Label

■ Pallet Label

APPENDIX- III

■ Source D-IC Power Sequence





- Input Signal : EPI

APPENDIX- IV-1

■ EXTV$_{BR-B}$ & Local Dimming Design Guide

1) When L-Dim Enable is “L", Vertical Sync Signal = System Dimming with 100Hz or 120Hz frequency.

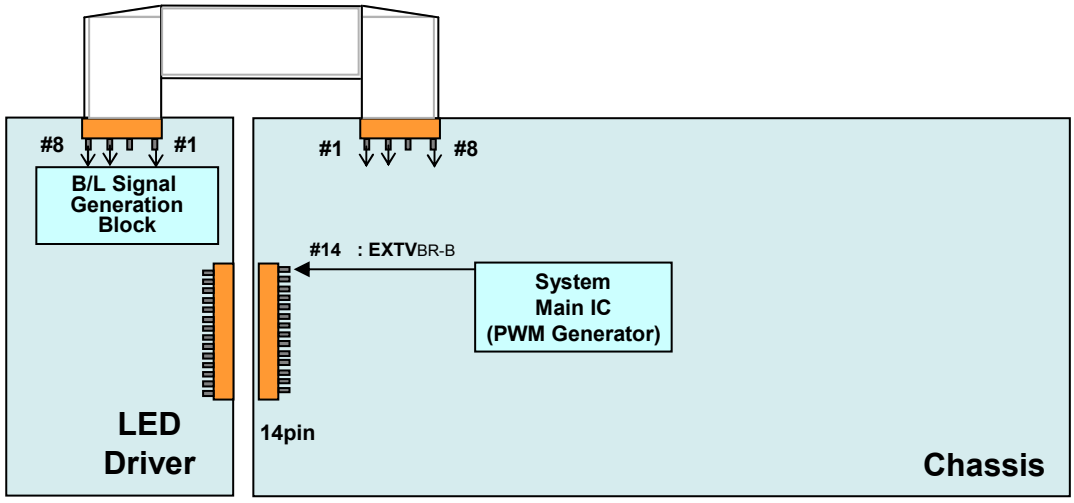
2) Local Dimming signals are synchronized with Vertical Sync Signal Frequency.

3) EXTV$_{BR-B}$ Specification (VCC = 3.3V) @ Local Dimming

a) High Voltage Range : 2.5 V ~ 3.6 V

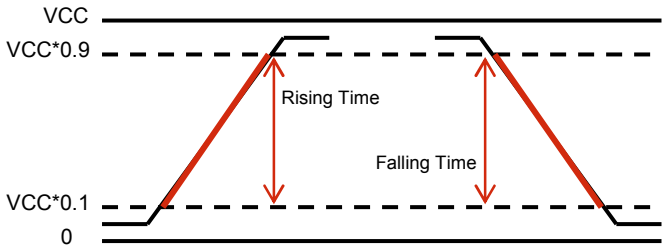
b) Low Voltage Range : 0.0 V ~ 0.7 V

(8pin)
#1 : Vertical Sync signal
#2 : No Connection
#3 : No Connection
#4 : Local Dimming Serial Data
#5 : GND
#6 : Local Dim Serial Clock
#7 : No Connection
#8 : No Connection



<With Driver Model>

EXTV$_{BR-B}$ Frequency	100 Hz for PAL 120 Hz for NTSC
Rising Time	MAX 10.0 μs
Falling Time	MAX 10.0 μs



Local Dimming Interface Design Guide

APPENDIX- IV-2

▶ Data Sequence (※ based on 4 Block)

8-bit : Indicator(1010_1010) / Command(8-bit) / Data1(8-bit) / Data2(8-bit) / ... / Data4(8-bit) / check_Sum(8-bit)

10-bit : Indicator(1010_0000_00) / Command(10-bit) / Data1(10-bit) / Data2(10-bit) / ... / Data4(10-bit) / check_Sum(10-bit)

▶ Data field Definition (※ based on 4 Block)

1. Indicator Byte : Start of data sequence
2. Command Byte
   - Bit 0 : Local-Dimming Enable ('1' : Enable, '0' : Disable)
   - Bit 1 : Scanning Enable ('1' : Enable, '0' : Disable)
   - Bit 2~6 : Reserved (Must be Low Level ('0'))
   - Bit 7 : Reverse Enable ('1' : Enable (Reverse), '0' : Disable (Normal))
3. Data Byte 1 ~ 4 : 8 / 10 -bit Local-dimming gray value
4. Check_Sum Byte = Indicator ^ Command ^ Data1 ^ Data2 ^ … Data4 (※ ^ : Exclusive OR)

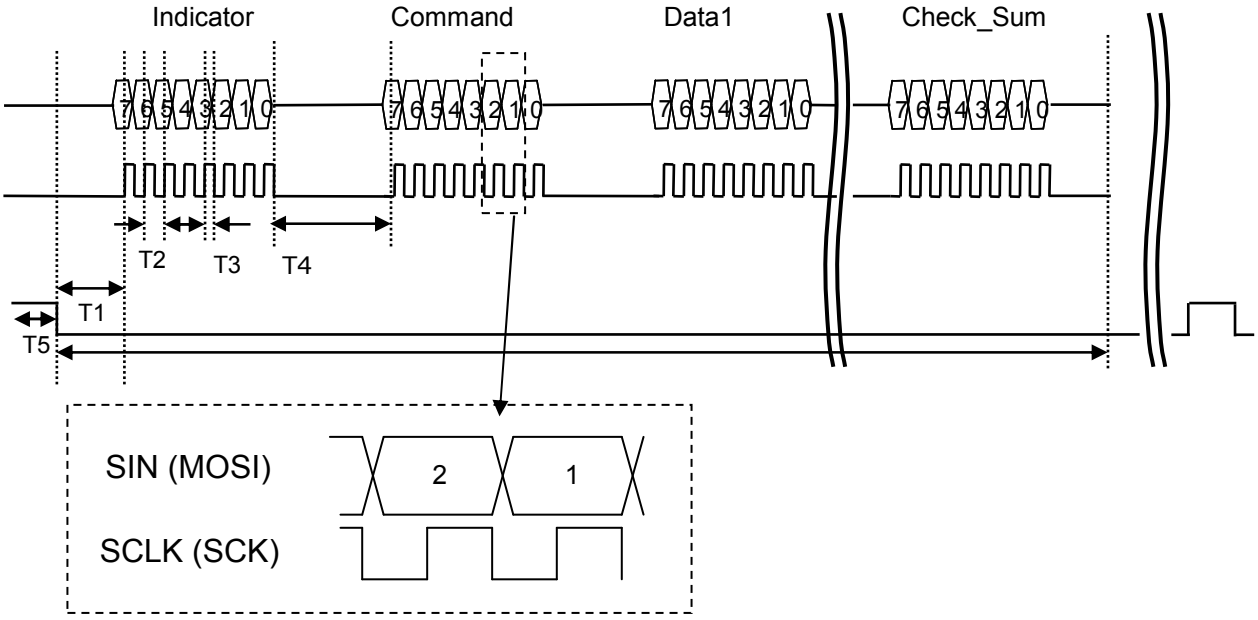
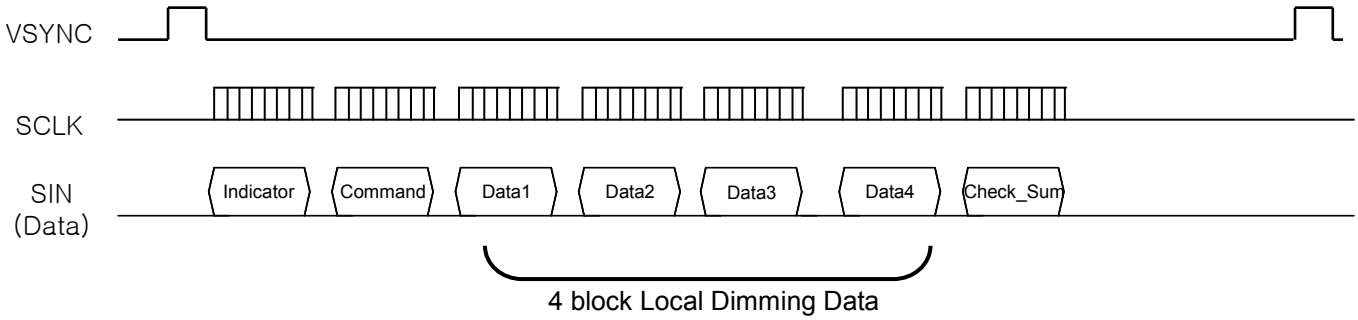


Table15. TIMING TABLE for Local Dimming Interface ※ SPI Clock Range : Min 100 [KHz], Max 500 [KHz]

Parameter (SCLK rising edge기준)	Values			Units
	Min	Typ	Max	
T1	6.00	-	30.00	us
T2	2.00	-	10.00	us
T3	1.00	-	5.00	us
T4	6.00	-	30.00	us
T5	10.00	-	40.00	us

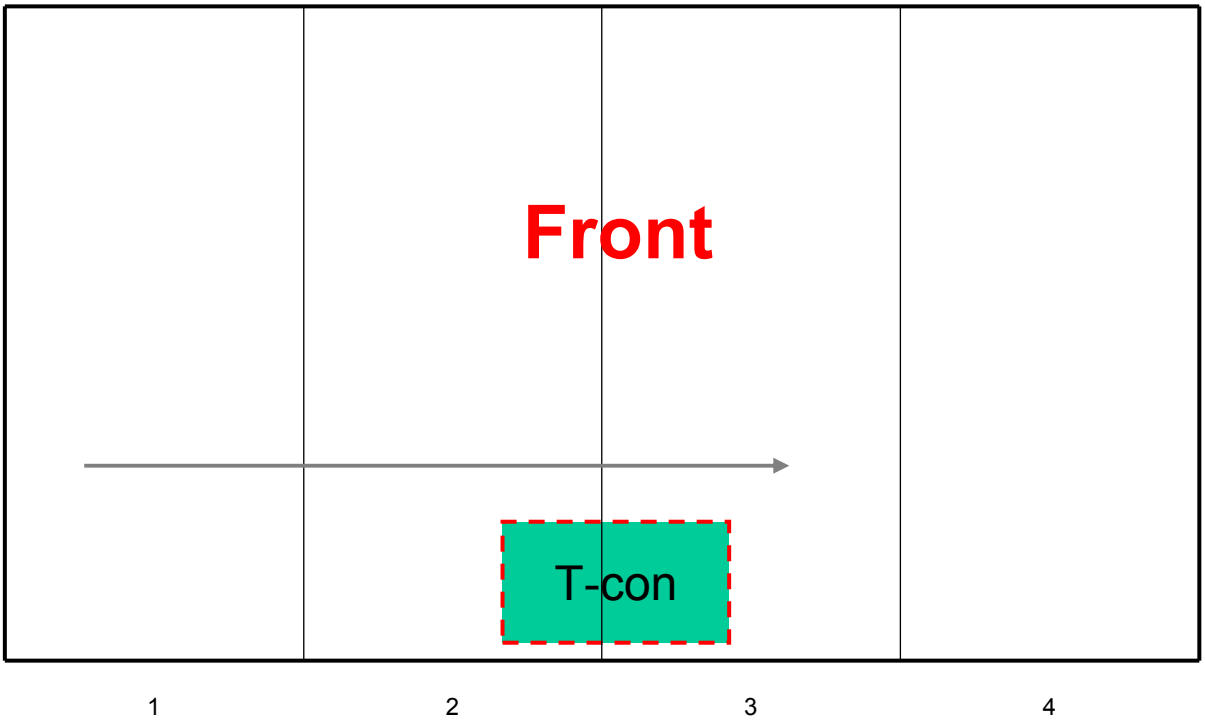
APPENDIX- IV-3

▶ Local Dimming Block Mapping



Reverse mode(T-con Down), Command Bit 7 : “1”

When reverse mode is selected, the scanning direction is shown in the figure

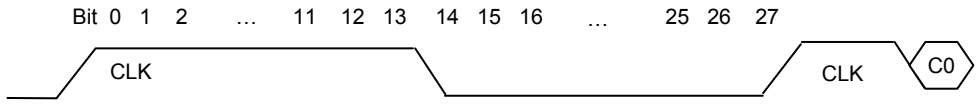


APPENDIX-V

■ EPI Input Protocol

1. Clock Training Pattern input mode

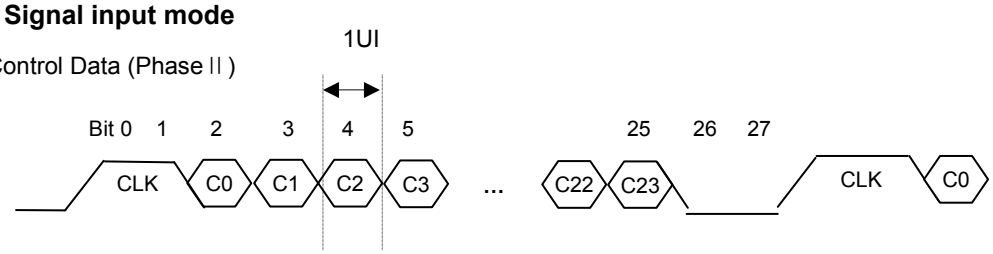
. Clock Training Pattern (Phase Ⅰ)



Bit 0 ~ Bit 13	Bit 14 ~ Bit 27
H	L

2. Control Signal input mode

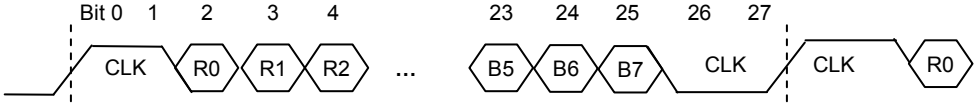
.Control Data (Phase Ⅱ)



Bit 0	Bit 1	Bit 2 ~ 25	Bit 26	Bit 27
H	H	Control Data	L	L

3. Display Data input mode

. RGB Data (Phase Ⅲ)



Bit 0	Bit 1	Bit 2 ~ 25	Bit 26	Bit27
H	H	R : Bit 2 ~ 9 / G : Bit 10 ~17 / B : Bit 18 ~ 25	L	L

APPENDIX- VI

■ Standard specification of Eyeglasses

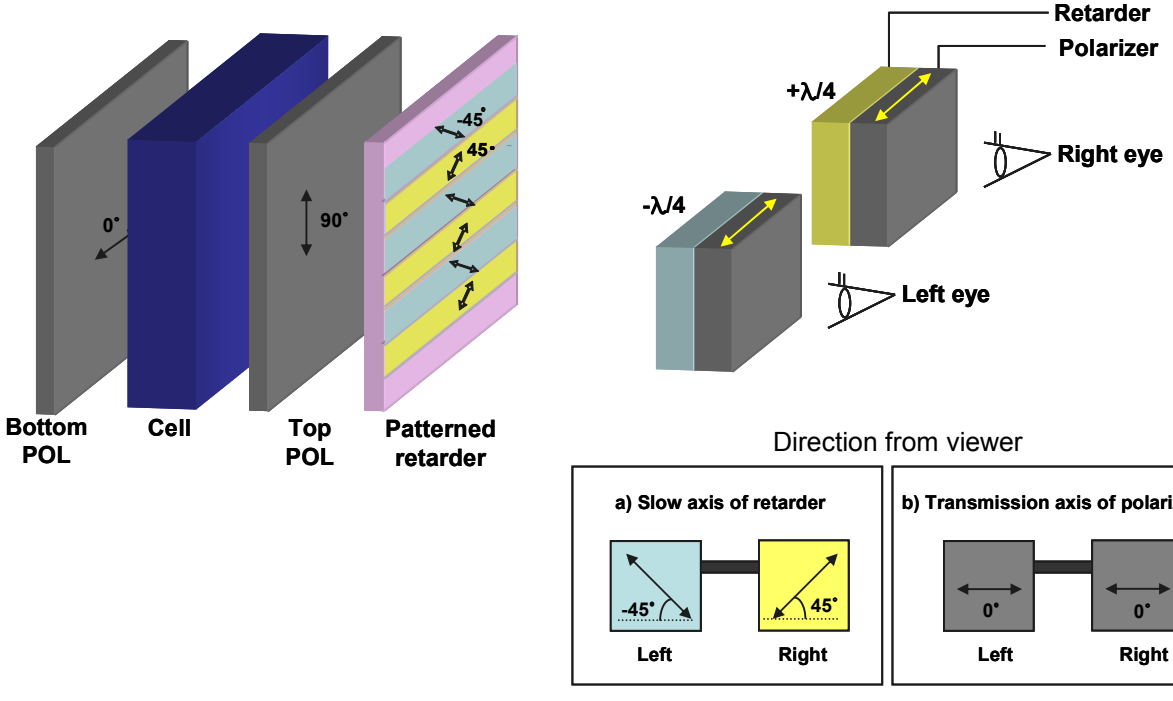
This is recommended data of Eyeglasses for LC320EUA-PFF1 model. (details refer to table)

For each item, depending on the eyeglass manufacturer tolerances may occur, this tolerance can affect 3D performance. (3D Crosstalk, 3D luminance, 3D viewing angle)

<Table. Standard specification of Eyeglasses>

Design item of Eyeglasses		Left	Right	Remark
Optical axis	a) Slow axis of retarder	-45˚	45˚	Refer to drawing
	b) Transmission axis of polarizer	0˚	0˚	
Retardation value	Retarder	125nm		@550nm

※Recommended polarizer
Polarization efficiency: more than 99.90%



(b) Configuration of Eyeglasses

<Drawing. Information of optical axis>

APPENDIX-VII

■ Management for Micro-crack by Laser Cutting

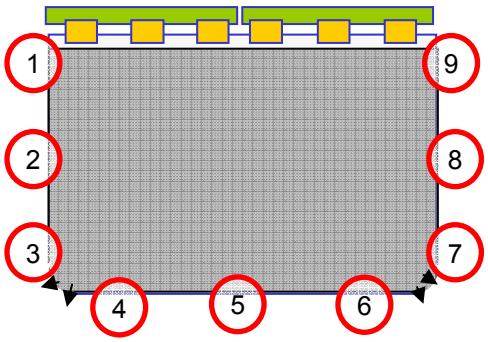
1. Subject of process : Laser cutting

2. Measuring cycle

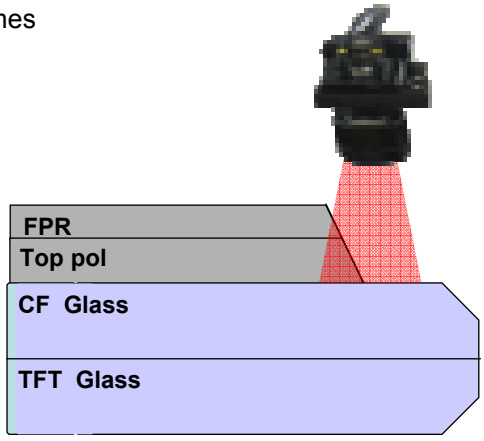
- Regular measuring : One of Fixer Ass'Y is measured in every 8 hours
- Irregular measuring : One of Fixer Ass'Y is measured when a model is changed

3. Measurement Method

- Measuring point : 9 Points



- Measuring Condition
  - Magnification of microscope : 50 times
  - Lighting Mode : Reflection Mode



4. Management standard

- Micro-crack length : Smaller than 50㎛ at Start①/End⑨ point, no micro-crack at the rest of point